Series A.C Circuit

$X_C = \frac{1}{2\pi fc}$ — $X_L = 2\pi fL$

D.C ⇒ S.C — O.C

* Average Power and P.f

$P = i * v$

$i = I_{max} \sin(\omega t + \theta_i)$

$\therefore P_{(t)} = V_m \sin(\omega t + \theta_v) * I_m \sin(\omega t + \theta_i)$ $\quad v = V_{max} \sin(\omega t + \theta_v)$

$\therefore P_{(t)} = I_m V_m \sin(\omega t + \theta_v) * (\sin \omega t + \theta_i)$

$\therefore P_{av} = \frac{1}{T} \int_0^T P(t)\, dt$

$\therefore \Rightarrow P_{av} = \frac{1}{2\pi} \int_0^{2\pi} \frac{I_m V_m}{2} \left[\cos(\theta_v - \theta_i) - \cos(2\omega t + \theta_v + \theta_i) \right] d(\omega t)$

ثابت لا يعتمد على الزمن للتكامل او ضربه * ωt

Note ⇒ $\sin \otimes_1 * \sin \otimes_2 = \cos(\otimes_1 - \otimes_2) + \cos(\otimes_1 + \otimes_2)$

$\cos(2\omega t + \theta_v + \theta_i)$ ⇐ التكامل صيطلع = صفر للجزء على شكل دالة الجاءة مقدمه فتالي تحت فيلغوا بعض او كلهن

$\therefore \Rightarrow P_{av} = \frac{V_m I_m}{4\pi} \left[\cos(\theta_v - \theta_i)\, \omega t \right]_0^{2\pi} = 0$

$\therefore P_{av} = \frac{V_m I_m}{2 * 4\pi} \cos(\theta_v - \theta_i) 2\pi = \frac{V_m I_m}{2+2} \cos(\theta_v - \theta_i)$

$\Rightarrow \because V_{rms} = V_m/\sqrt{2} \qquad I_{rms} = I_m/\sqrt{2}$

$\therefore P_{av} = V_{rms} I_{rms} \underbrace{\cos(\theta_V - \theta_I)}_{= P.f}$

$\therefore P_{av} = VI\ P.f$ ← Real active.

لاحظ في av power فيه زوايا ... بس لما نعوض بالقانون هنعوض بـ V, I كقيمة صغيرة بدون زوايا

لو الدايرة AC ← $P_{av} = VI\cos(\theta_V - \theta_I)$

لو الدايرة DC ← $P = I^2R = I.V$

$\Rightarrow$ لحساب الـ Power factor القانون العام

$P_F = \frac{P_{av}}{VI}$

$\Rightarrow$ في حالة المقاومة R

$\Downarrow P_{av} = VI\cos\theta$ = $V_{rms} I_{rms}$ "Watt"

الزاوية بين الجهد والتيار داخل المقاومة = صفر

$\Rightarrow$ في حالة الملف L

$P_{av} = VI\cos\theta$ = Zero

$\theta = 90°$ الزاوية بين الجهد والتيار في الملف

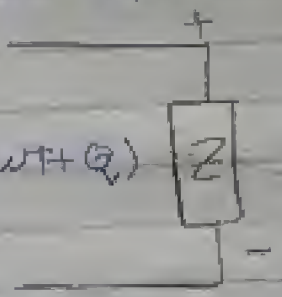
$\Rightarrow$ في حالة المكثف C

$P_{av} = VI\cos\theta$ = Zero

$-\theta = I$ (سبق V_{rms}) الزاوية داخل المكثف

$\therefore$ المقاومة هي الوحيدة اللي P_{av} لها

$Z \triangleq$ impedance. $\quad i = I_M \sin(\omega t + \theta_i)$



$v = V_M \sin(\omega t + \theta_v)$

Phasor: حولنا من الزمن لـ V و I

$$\underline{I} = I_{Rms} \angle \theta_i$$

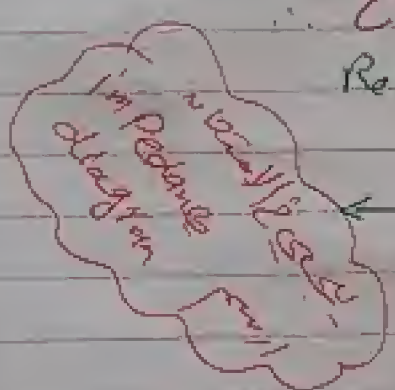
$$\underline{V} = V_{Rms} \angle \theta_v$$

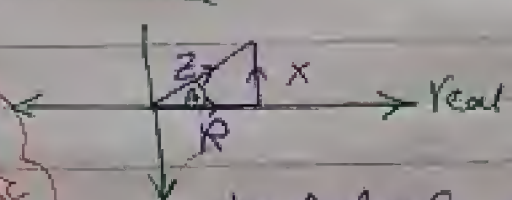
$$\Rightarrow \underline{Z} = \frac{\underline{V}}{\underline{I}} = \frac{V_{Rms} \angle \theta_v}{I_{Rms} \angle \theta_i} = \frac{V}{I} \angle (\theta_v - \theta_i)$$

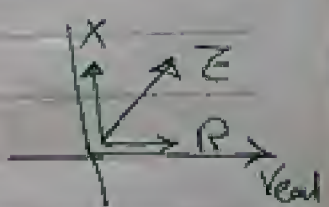
$$= |Z| \angle \theta_z = |Z| \angle \theta \quad \rightarrow \text{Polar form}$$

$$\therefore \underline{Z} = R + jX \quad \rightarrow \text{Cartizian form}$$

Resistance ← R, X → Reactance



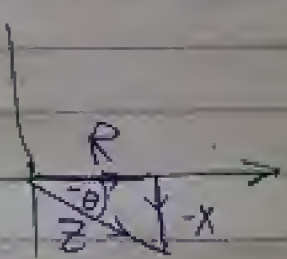




impedance diagram

→ lagging power factor

→ leading power factor



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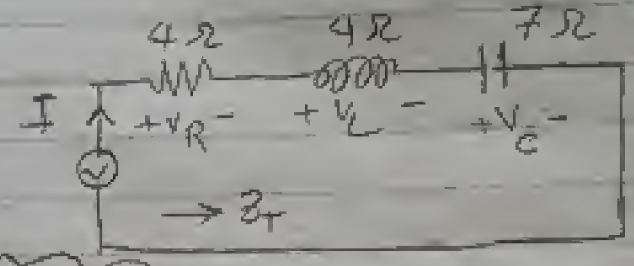
ex:-



$e = 50\sqrt{2}\sin \omega t$

$\Downarrow$

$e = 50 \angle 0$

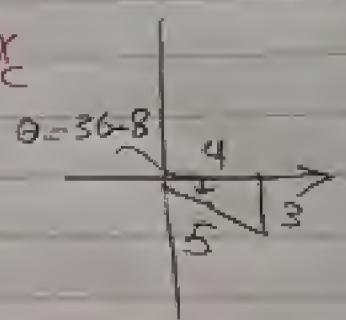
Solution

$\Rightarrow Z_T = Z_R + Z_L + Z_C = R\angle 0 + j(X_L - X_C)$

$\rightarrow R = R\angle 0 = R + j.0$

$Z_L = 0 + jX_L \qquad Z_C = 0 - jX_C$

$\therefore Z_T = 4 - j3 \Rightarrow$ impedant diagram



$Z_T = 5 \angle -36.8$

$P_f = \cos\theta = \frac{R}{Z} = \frac{4}{5} = .8$ lead

$\Rightarrow I = \frac{50\angle 0}{5\angle -36.87} = 10\angle 36.87$

$\therefore i = 10\sqrt{2}\sin(\omega T + 36.87)$

$\Rightarrow V_R = I\frac{R\angle 0}{Z} = 50\angle 0 * \frac{4\angle 0}{5\angle -36.87} = 40\angle 36.87$

$\Rightarrow V_L = I Z_L = 10\angle 36.87 * 4\angle 90 \quad \because V_L = I\frac{L\angle 90}{Z}$

$\therefore V_L = 40\angle 126.87$

$\Rightarrow V_C = I Z_C = 10\angle 36.87 * 7\angle -90 = 40\angle -53.13$

$$P_S = E I \cos\theta = 50 * 10 \cos(\theta)$$

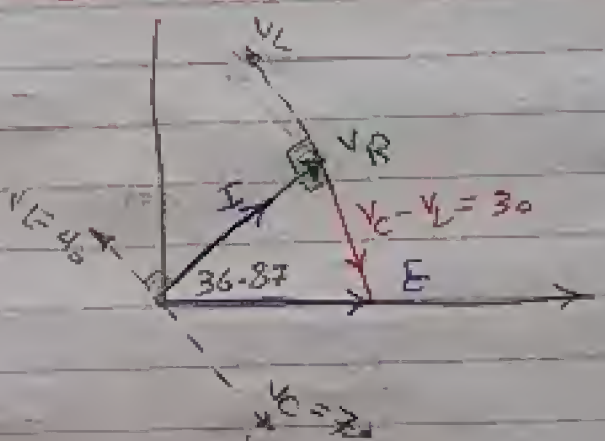
$$P_S = 500 * \frac{4}{5} = 400 \text{ watt}$$

$$P_R = I^2 R = (10)^2 * 4 = 400$$

أو V_R / R

$P_L = 2\angle 0$ $\quad$ $P_C = 2\angle 0$

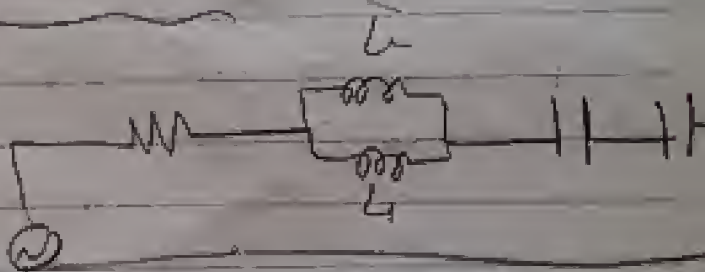
الملف والمكثف طبعاً الـ P = صفر لأنهما عناصر لا تستهلك Power



$$\Rightarrow L = \frac{L_1 L_2}{L_1 + L_2} = \checkmark$$

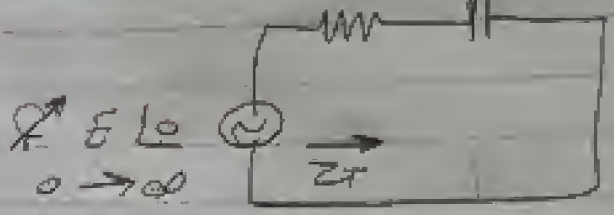
$$X_L = \omega L = 2\pi f L$$

$$\Rightarrow C = \frac{C_1 C_2}{C_1 + C_2} \qquad \Rightarrow X_C = \frac{1}{\omega C}$$



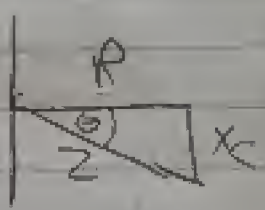
* Frequency Response

دائرة تردد متغير



$$Z_T = R - j X_C$$

$$Z_T = \sqrt{R^2 + X_C^2} \qquad \boxed{-\tan^{-1}\left(\frac{X_C}{R}\right)}$$



$$\Rightarrow Z_T = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2} \qquad \boxed{-\tan^{-1}\left(\frac{1}{\omega C R}\right)} \quad \theta_Z$$

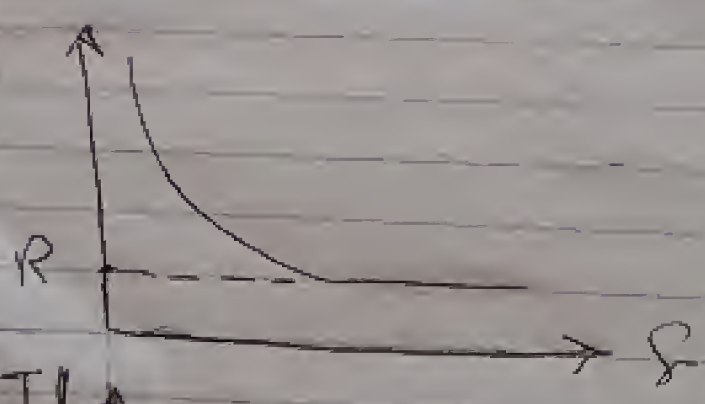
$$\omega = 2\pi f C$$

$$I = \frac{\varepsilon L_0}{\sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}} \qquad \boxed{-\tan^{-1}\left(\frac{1}{\omega C R}\right)}$$

$|Z|$

at $f = 0 \rightarrow Z = \infty$

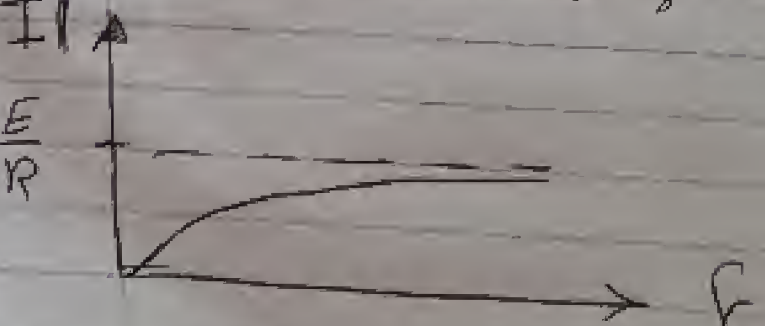
at $f = \infty \rightarrow Z = R$



at $f = 0$ $\quad I = 0$

at $f = \infty$ $\quad I = \frac{\varepsilon}{R}$

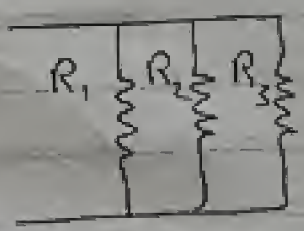
$|I|$



* parallel AC CurCuit :-

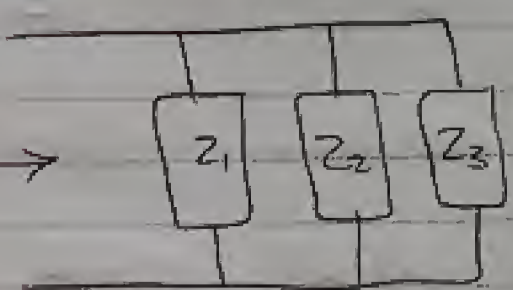
(1) At DC

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$



$$G_i = G_1 + G_2 + G_3$$

(2) At AC

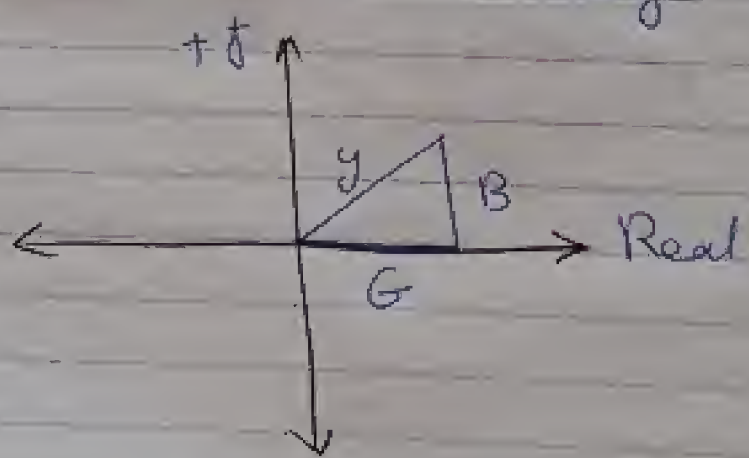


$$\frac{1}{Z_i} = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3}$$

$$y_i = y_1 + y_2 + y_3 \quad : \Rightarrow y = \frac{1}{Z}$$

admitance
$y = \frac{1}{Z} = G \pm jB$ ← Susbtance $= \frac{1}{X}$ $= y \angle \theta$
Conductance
impedance

$$\theta_y = -\theta_z$$



admitance diagram

Y

المقاومة ← $Y_R = \frac{1}{Z} = \frac{1}{R}\angle 0$

$Y_R = G\angle 0$

الملف ← $Y_L = \frac{1}{Z} = \frac{1}{X_L\angle 90} = \frac{1}{X_L}\angle -90$

... angle جبنا "90" من الطالبة بتنسى الـ

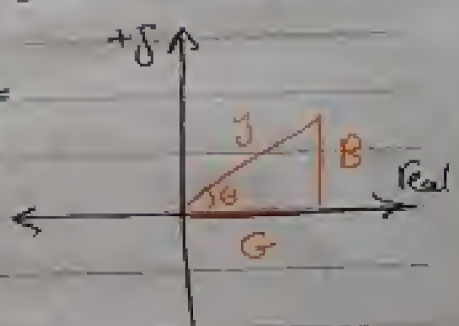
$Y_L = B_L\angle 90 = -jB_L$

المكثف ← $Y_C = \frac{1}{Z_C} = \frac{1}{X_C}\angle -90 = \frac{1}{X_C}\angle 90$

$\therefore Y_C = B_C\angle 90 = jB_C\angle 90$

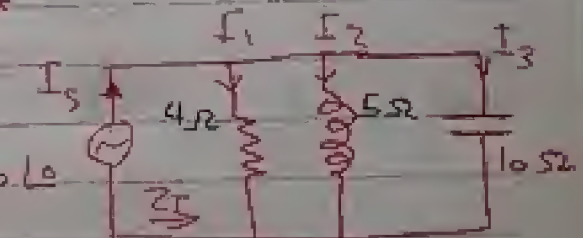
admittance ← لما مقلت الـ ... رسوم بكسر

في الربع الأول بتكون الـ element مكثف "C"



* الطالبة ← هات كل حاجة ...

(Solution)

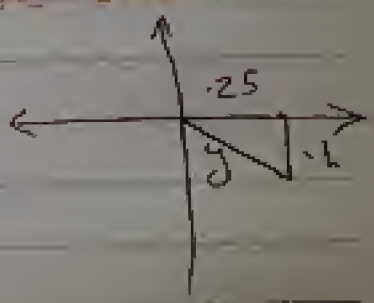


$R \Rightarrow Y_T = Y_1 + Y_2 + Y_3$

$Y_T = \frac{1}{4} + \frac{1}{5\angle 90} + \frac{1}{10\angle -90} = .269\angle -21.8$

* الخطأ ... بتنسى "الزاوية" والسالب بتسقط

$\therefore \Rightarrow Y_T = .25 + j0.1$



$\therefore Z_T = \frac{1}{Y_1} = 3.714\angle 21.8$

$$\Rightarrow P.F = Gs\,\theta_z = Gs\ 21.8 = 0.9285$$

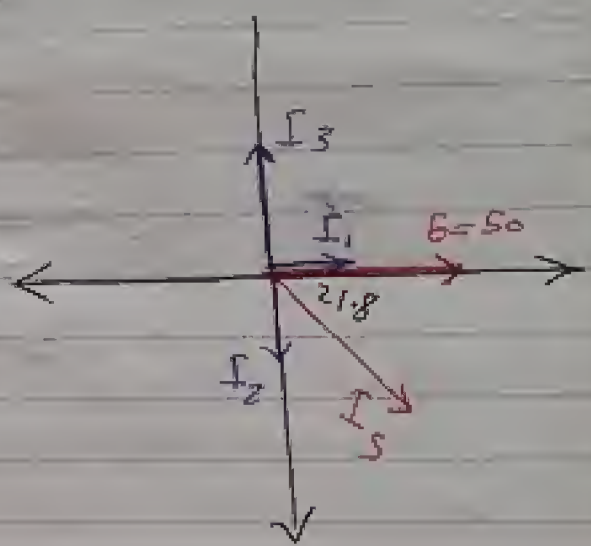
$$Pf = 0.9285 \quad \text{"lag"}$$

$$\Rightarrow I_s = \frac{E}{Z} = \frac{50\angle 0}{3.714\angle 21.8} = 13.46\angle -21.8$$

$$\Rightarrow I_1 = \frac{E\angle 0}{4\angle 0} = \frac{50}{4}$$

$$\Rightarrow I_2 = \frac{50\angle 0}{5\angle 90} = 10\angle -90$$

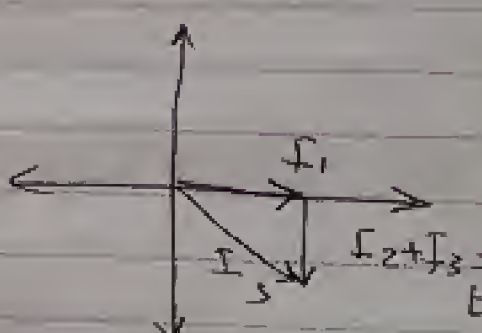
$$\Rightarrow I_3 = \frac{50\angle 0}{10\angle -90} = 5\angle 90$$



$$\Rightarrow P_s = EI_s \cdot P.F$$

$$\therefore P_s = 50 * 13.4 * .9 = 625$$

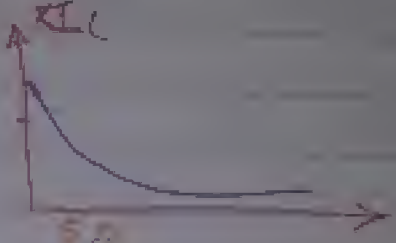
$$P_R = \frac{E^2}{R_1} = \frac{(50)^2}{4} = 626$$



phasor diagram

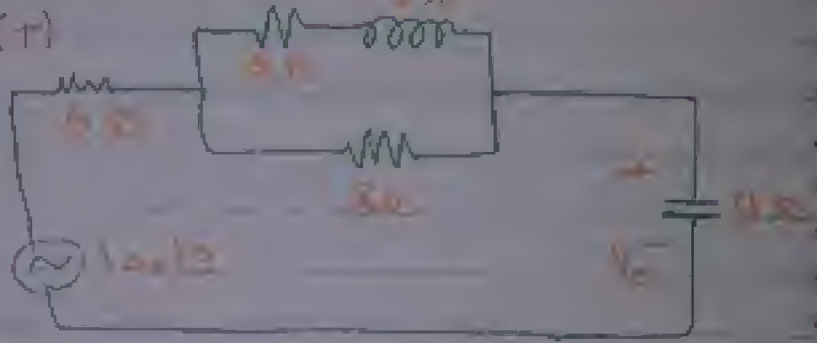
معادلة التيار

$$X_L = I_S \frac{R}{R + jX_L} = \frac{IR}{\sqrt{R^2 + (X_L)^2}} \angle -\tan^{-1}(X_L/R)$$



at $f = 0 \Rightarrow I_L = I$

→ Sketch P_1, $I_1(T)$
PF = ??



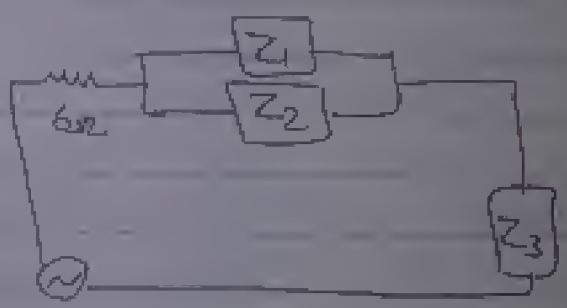
$$Z_1 = 6 + 5 \angle 0° = 6 + j5 = 7.81 \angle 39.8$$

$$Z_2 = 8 \angle 0° \quad , \quad Z_3 = 4 \angle -9°$$

$$Z_4 = Z_1 // Z_2 = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

$$Z_4 = \frac{7.8 \angle 39.8 \times 8 \angle 0°}{6 + 8 + j5}$$

$$\therefore Z_4 = 4.2 \angle 2.16$$



$$Z_T = 6 + Z_4 + Z_3$$

$$\therefore Z_T = 6 + 4.2 \angle 2.16 + 4 \angle -9° = 8.343 \angle -1.8$$

$$\Rightarrow I_T = \frac{100 \angle 0}{Z_T} = 12 \angle 17.8$$

$P.f = \cos(-17.87)$ leading.

$\Rightarrow V_C = I_T Z_C = 12 \angle 17.87 * 4 \angle -90$

$e = 100\sqrt{2} \sin \omega t$

$i = 12\sqrt{2} \sin(\omega t + 17)$

ازاي تحول من ∇ لـ Y

* ازاي تحول المقاومات من الشكل ∇ الى المقاومات على شكل Y ؟!

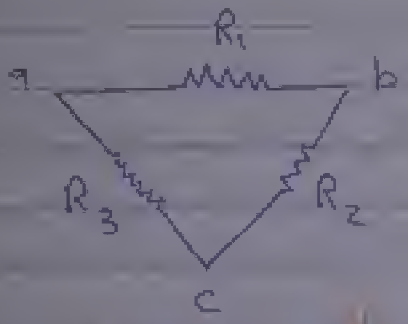


fig 1

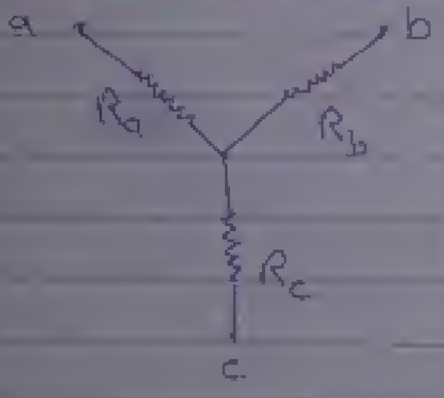
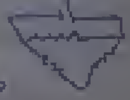


fig 2

* هنتعامل على الشكلين من ناحية الأطراف ونشوف المقطعتين اللي عندنا ونفرض بطارية موصلة بالمقطعتين مرة في fig1 ومرة في fig2 ونجيب المحصلة للمقاومات ونساويهم ببعض ... يعني مثلاً هنجيب من fig1 هيبقى لها المقاومة R1 والمقطعتين a b هنفرض البطارية بينهم وفي نفس الوقت نجيب على fig2 من [illegible] ونوصل بطارية بين a, b ونجيب RT



ونكرر العملية دي ٣ مرات مرة ع الـ bc ومرة ac

Solution

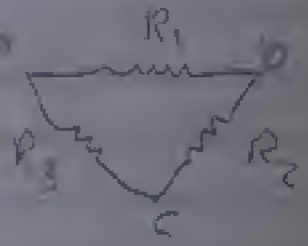
Fig 1 Fig 2

$$\frac{R_1(R_2+R_3)}{R_1+R_2+R_3} = R_a + R_b \longrightarrow (1)$$

$$\frac{R_1R_3+R_2R_3}{R_1+R_2+R_3} = R_a + R_c \longrightarrow (2)$$

$$\frac{R_1R_2+R_2R_3}{R_1+R_2+R_3} = R_c + R_b \longrightarrow (3)$$

$$\Rightarrow R_a = \frac{R_1 * R_3}{R_1+R_2+R_3} \longrightarrow *$$

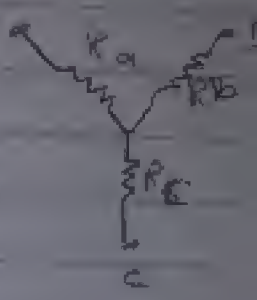


$$\Rightarrow R_b = \frac{R_1 * R_2}{R_1+R_2+R_3} \longrightarrow **$$

$$\Rightarrow R_c = \frac{R_2 * R_3}{R_1+R_2+R_3} \longrightarrow ***$$

وهنا نلاحظ لكي نجد R_a مثلاً ..
نضرب المقاومتين اللي جانبين من النقطة a وتقسم على مجموع المقاومات
وكذلك لكي نجد R_b نضرب
اللي جانبين من النقطة b وتقسم
على R_1 تولك .. وكذلك R_c

Class ***** ***



$$\Rightarrow R_1 = R_a + R_b + \frac{R_a R_b}{R_c}$$

$$\Rightarrow R_2 = R_b + R_c + \frac{R_b R_k}{R_a}$$

$$\Rightarrow R_3 = R_a + R_b + \frac{R_a \cdot R_b}{R_c}$$

If R_T =

$R_1 = 2\Omega$

$5 = 2a$